

DETAILED REQUIREMENTS DOCUMENT  
FOR THE  
RADIANT HEAT TRANSFER FACILITY  
POST-TEST DATA REDUCTION PROGRAM

NASA CR-

141729

Job Order 83-157

(NASA-CR-141729) DETAILED REQUIREMENTS  
DOCUMENT FOR THE RADIANT HEAT TRANSFER  
FACILITY POST-TEST DATA REDUCTION PROGRAM  
(Lockheed Electronics Co.) 43 p HC \$3.75

N75-20654

Unclass

CSSL 14B G3/34 18157

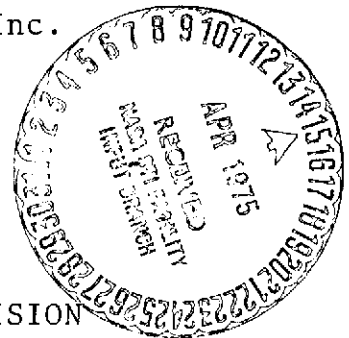
Prepared By

Lockheed Electronics Company, Inc.  
Aerospace Systems Division  
Houston, Texas

Contract NAS 9-12200

For

INSTITUTIONAL DATA SYSTEMS DIVISION



*National Aeronautics and Space Administration*  
**LYNDON B. JOHNSON SPACE CENTER**

*Houston, Texas*


February 1975

LEC-5147

DETAILED REQUIREMENTS DOCUMENT  
FOR THE  
RADIANT HEAT TRANSFER FACILITY  
POST-TEST DATA REDUCTION PROGRAM

Job Order 83-157

PREPARED BY


  
J. F. Brose  
Lockheed Electronics Company, Inc.


APPROVED BY


LEC

  
C. E. Hutchinson, Supervisor  
On-site Processing Section

NASA

 2-24-75  
W. D. Poates, Technical  
Monitor, Data Processing  
Branch

  
W. N. Fitzpatrick, Manager  
Data Processing Systems  
Department

CONCURRENCE  
  
A. D. Gist, Head  
Instrumentation and Data  
Systems Section

Prepared By

Lockheed Electronics Company, Inc.

For

Institutional Data Systems Division

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION  
LYNDON B. JOHNSON SPACE CENTER  
HOUSTON, TEXAS

February 1975

**TECHNICAL REPORT INDEX/ABSTRACT**  
(See instructions on reverse side.)

<b>1. TITLE AND SUBTITLE OF DOCUMENT</b>  Detailed Requirements Document for the Radiant Heat Transfer Facility Post-Test Data Reduction Program		<b>2. JSC NO.</b>  JSC-09403
<b>3. CONTRACTOR/ORGANIZATION NAME</b>  Lockheed Electronics Company, Inc.	<b>4. CONTRACT OR GRANT NO.</b>  NAS 9-12200	
<b>5. CONTRACTOR/ORIGINATOR DOCUMENT NO.</b>  LEC-5147	<b>6. PUBLICATION DATE (THIS ISSUE)</b>  February 1975	
<b>7. SECURITY CLASSIFICATION</b>  Unclassified	<b>8. OPR (OFFICE OF PRIMARY RESPONSIBILITY)</b>  W. D. Poates	
<b>9. LIMITATIONS</b> GOVERNMENT HAS UNLIMITED RIGHTS <input checked="" type="checkbox"/> YES <input type="checkbox"/> NO	<b>10. AUTHOR(S)</b>  J. F. Brose	
<b>11. NO. STATE LIMITATIONS AND AUTHORITY</b>  		
<b>11. DOCUMENT CONTRACT REFERENCES</b> WORK BREAKDOWN STRUCTURE NO. N/A		<b>12. HARDWARE CONFIGURATION</b> SYSTEM N/A
CONTRACT EXHIBIT NO. N/A		SUBSYSTEM N/A
DRL NO. AND REVISION N/A		MAJOR EQUIPMENT GROUP  N/A
DRL LINE ITEM NO. N/A		
<b>13. ABSTRACT</b>  The Detailed Requirements Document for Radiant Heat Transfer Facility Post-Test Data Reduction Program defines the requirements and functional specifications for a program to process test data obtained by the Radiant Heat Data Acquisition System.		
<b>14. SUBJECT TERMS</b>  <u>Shuttle</u>  <u>Thermal Protection System</u>  <u>Fatigue Test</u>		

## FOREWORD

The Detailed Requirements Document for the Radiant Heat Transfer Facility Post-Test Data Reduction Program defines the requirements and functional specifications for a program to process test data obtained by the Radiant Heat Data Acquisition System (RHDAS). It has been prepared by personnel of the Data Processing Systems Department, Lockheed Electronics Company, Inc., (LEC), in response to a request by the Institutional Data Systems Division (IDSD), Data Processing Branch of the National Aeronautics and Space Administration (NASA).

## CONTENTS

Section		Page
1.0	<u>SYSTEM OVERVIEW</u> . . . . .	1-1
1.1	IDENTIFICATION. . . . .	1-1
1.2	BACKGROUND. . . . .	1-1
1.2.1	Objectives . . . . .	1-1
1.2.2	Responsibilities . . . . .	1-2
1.2.3	References . . . . .	1-2
1.3	GENERAL DESCRIPTION . . . . .	1-2
1.4	ASSUMPTIONS AND CONSTRAINTS . . . . .	1-3
1.5	EQUIPMENT . . . . .	1-3
2.0	<u>PROGRAM REQUIREMENTS</u> . . . . .	2-1
2.1	INPUT REQUIREMENTS. . . . .	2-1
2.1.1	RHDACS Test Tape . . . . .	2-1
2.1.2	Lead Cards . . . . .	2-15
2.2	PROCESSING REQUIREMENTS . . . . .	2-17
2.3	OUTPUT REQUIREMENTS . . . . .	2-21
2.3.1	Tabular Listings . . . . .	2-21
2.3.2	Time History Plots . . . . .	2-22
2.3.3	Quality Control Output . . . . .	2-23
2.3.4	Binary Tape. . . . .	2-24
2.4	PERFORMANCE REQUIREMENTS. . . . .	2-24
3.0	TEST REQUIREMENTS. . . . .	3-1
3.1	TEST DATA SOURCES . . . . .	3-1

Section	Page
3.2 GENERAL TEST APPROACH . . . . .	3-1
3.3 ACCEPTANCE CRITERIA . . . . .	3-1
4.0 <u>PRODUCTION IMPLEMENTATION</u> . . . . .	4-1

## Appendix

ASCII AND CAN CODE CHARACTER SETS. . . . .	A-1
--	-----

## FIGURES

Figure		Page
1-1	Data flow for RHTF processing . . . . .	1-4
2-1	RHDACS tape format. . . . .	2-2
2-2	Narrative File format . . . . .	2-4
2-3	Type File format. . . . .	2-5
2-4	Coefficients File format. . . . .	2-8
2-5	Test Configuration File format. . . . .	2-9
2-6	Groups File format. . . . .	2-14
2-7	Test Data File format . . . . .	2-16

## ABBREVIATIONS AND ACRONYMS

A/D	Analog to digital
ANSI	American National Standards Institute
ASCII	American Standard Code for Information Interchange
bpi	Bits per inch
CALK	Calibration constant
CAN	Compressed alphanumeric
CRT	Cathode ray tube
EOF	End-of-file
EU	Engineering units
ID	Identification
IDSD	Institutional Data Systems Division
LEC	Lockheed Electronics Company, Inc.
mV	Millivolt
NASA	National Aeronautics and Space Administration
NBS	National Bureau of Standards
RHDACS	Radiant Heat Data Acquisition System
RHTF	Radiant Heat Test Facility
SEL	Systems Engineering Laboratory
TPS	Thermal Protection System
TDAS	Transdata Acquisition System
V	Volt
ZMV	Zero millivolt

## 1.0 SYSTEM OVERVIEW

### 1.1 IDENTIFICATION

NASA Title: Radiant Heat Transfer Facility Data Reduction Program

Job Order: 83-157

NASA Division: IDSD, Data Processing Branch

### 1.2 BACKGROUND

#### 1.2.1 Objectives

The Radiant Heat Test Facility (RHTF) in NASA Building 260 is acquiring a new real-time data acquisition and control system to support the testing of Shuttle Thermal Protection System (TPS) panels. The TPS specimens will be tested in a combined environment simulating altitude, loading, and heating. The normal duration of a test will be a period of 1 hour, but tests can extend as long as 2 hours. The primary objective is to detect structural fatigue from repeated testing.

Thermocouples, strain gauges, linear deflection transducers, and radiometers will record data during the tests. The program described in this document (the RHTF program) will provide post-test data reduction.

The RHTF program will contain some of the capabilities of the programs which currently process data from the Transdata Acquisition System (TDAS) and the Systems Engineering Laboratory (SEL) System, which were used previously to record radiant-

heat-test data. It will provide the necessary data conversions for both tabular and/or graphical representation of the test data.

### 1.2.2 Responsibilities

The Data Processing Systems Department of Lockheed Electronics Company, Inc., has the responsibility of coordinating with the customer to define and document the requirements and to develop and implement the program.

### 1.2.3 References

The following reference material is related to these detailed requirements.

- NASA/LEC Task Agreement 14, Radiant Heat Test Facility Data Reduction Program Development.
- Job Order 83-157.
- *Program Documentation for Transdata Acquisition System - 200 Channel*, LEC-0530, July 1973.

## 1.3 GENERAL DESCRIPTION

The primary function of the post-test processing program will be the conversion of the data obtained from the various instrumentation types to engineering units for both tabular and graphical display. The digital data tape recorded by RHDACS contains essential information which can be used in the reduction process. Five files of descriptive and control information are contained on the tape, in addition to the data file. These five files are Narrative, Type, Coefficients, Test

Configuration, and Groups. The format and content are discussed individually in section 2.0. The program will utilize this information where applicable to minimize card input; it will also provide a card input override capability of tape supplied parameters. The data flow is shown in figure 1-1.

The format of the output tape produced by RHDACS, which will be input to the post-test processing program, is described in full for the purpose of maintaining continuity and to provide system background. Information necessary for processing will be so indicated.

#### 1.4 ASSUMPTIONS AND CONSTRAINTS

The input tape format and content described in section 2.0 will be subject to changes currently being proposed. The impact of these changes is unknown at this time; however, the changes will include the incorporation of coefficients for an exponential equation and the restructuring of the Coefficients File. The current description and content of this file may be found in section 2.1.1.3.

#### 1.5 EQUIPMENT

The program will be written for the UNIVAC 1108/1110 using the EXEC 8 monitoring system and the FR80 and SC4060 film plotters.

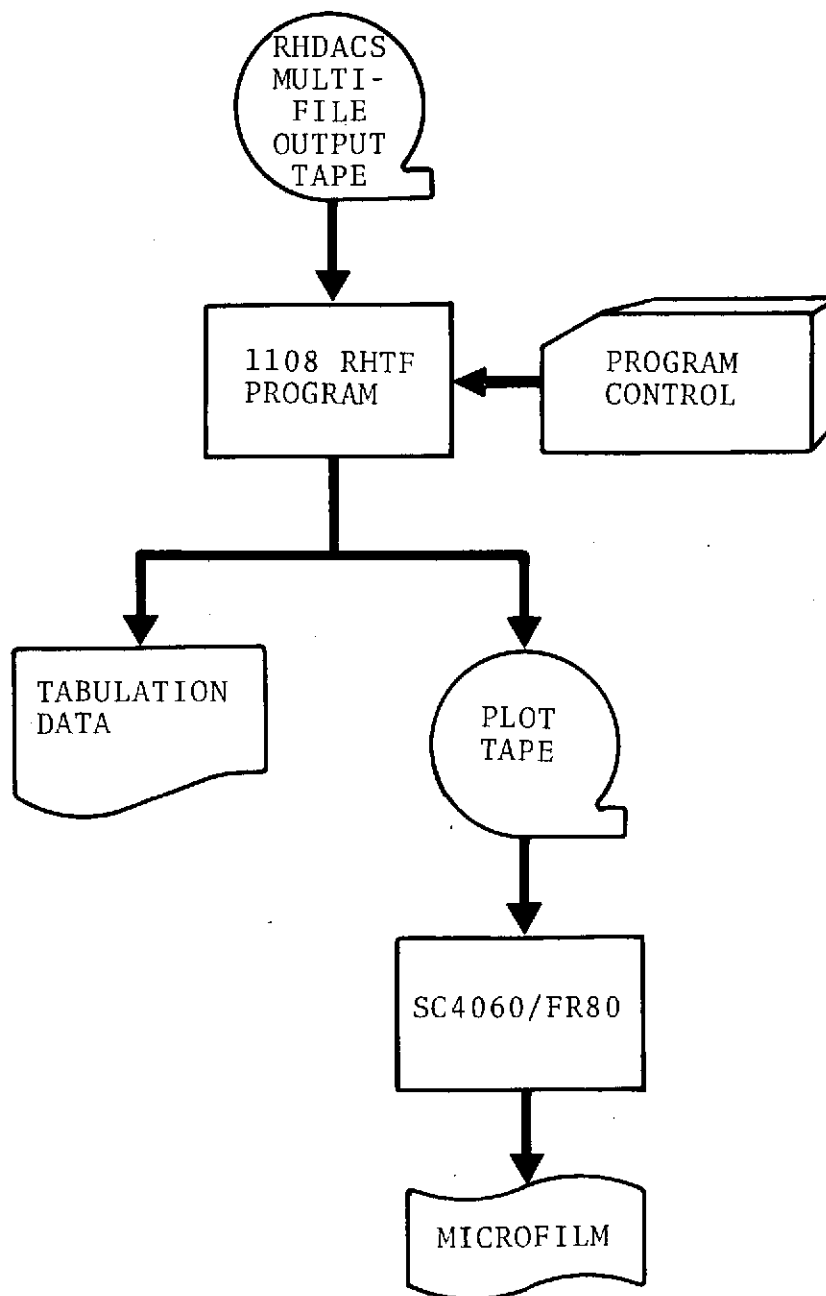


Figure 1-1. - Data flow for RHTF processing.

## 2.0 PROGRAM REQUIREMENTS

### 2.1 INPUT REQUIREMENTS

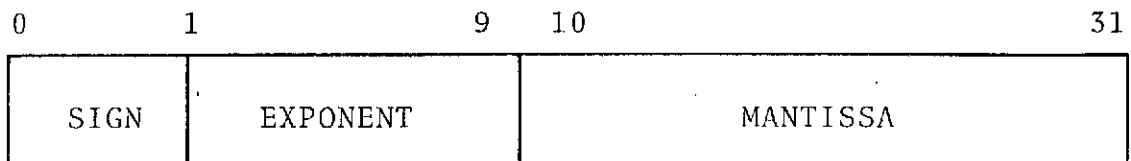
Input data will be obtained from the tape(s) generated by the RHDACS and the necessary lead cards to facilitate processing.

#### 2.1.1 RHDACS Test Tape

The RHDACS output tape, which will be used as input to the RHTF program, contains six files. The first five files contain descriptive information regarding test conditions, channel identifications (ID's), calibration constants, and other data used during real-time processing. The sixth file contains the raw data to be processed.

The RHDACS output tape is an odd-parity nine-track tape written at 800 bpi. The format is reflected in figure 2-1. Each file has a unique format, which is discussed individually. American Standard Code for Information Interchange (ASCII) and compressed alphanumeric (CAN) coded character sets are used. These are defined in the appendix.

The floating point notation used consists of a double 16-bit word. The exponent or characteristic is biased by  $400_8$ . Negative numbers are Two's Complemented.



File  
number

1.	NARRATIVE FILE
	EOF
2	TYPE FILE
	EOF
3	COEFFICIENTS FILE
	EOF
4	CONFIGURATION FILE
	EOF
5	GROUPS FILE
	EOF
6	TEST DATA FILE
	EOF

Figure 2-1. - RHDACS tape format.

A tape will contain only one test. However, a test may continue to another reel, and the second reel will contain the first five files of test description repeated at the first of the tape.

2.1.1.1 Narrative File. The Narrative File contains the test identification and narrative description of the test which will be input at the time the test is conducted. Each of the 20 records in the file consists of forty 16-bit words. The format is shown in figure 2-2.

The header record contains the number of lines of narrative (maximum of 19). Each cathode ray tube (CRT) line equates to one record and contains 80 ASCII characters of test identification. Included in the narrative will be a test identification consisting of a limited number of characters. The postprocessing program to be developed will be required to output all information contained in this file to the line printer.

2.1.1.2 Type File. The Type File contains static data associated with each transducer type. The data is largely for the purpose of converting millivolts to engineering units. Each of the 48 records in the file contains thirteen 16-bit words. The file holds data for a maximum of 48 transducer types. The format is shown in figure 2-3.

Only information contained in words 5 through 11 is required for post-test processing. Words 1 through 4 contain the transducer type name in eight ASCII characters. Words 5 through 8 contain the engineering units of the transducer type in eight ASCII characters. Word 9 consists of the

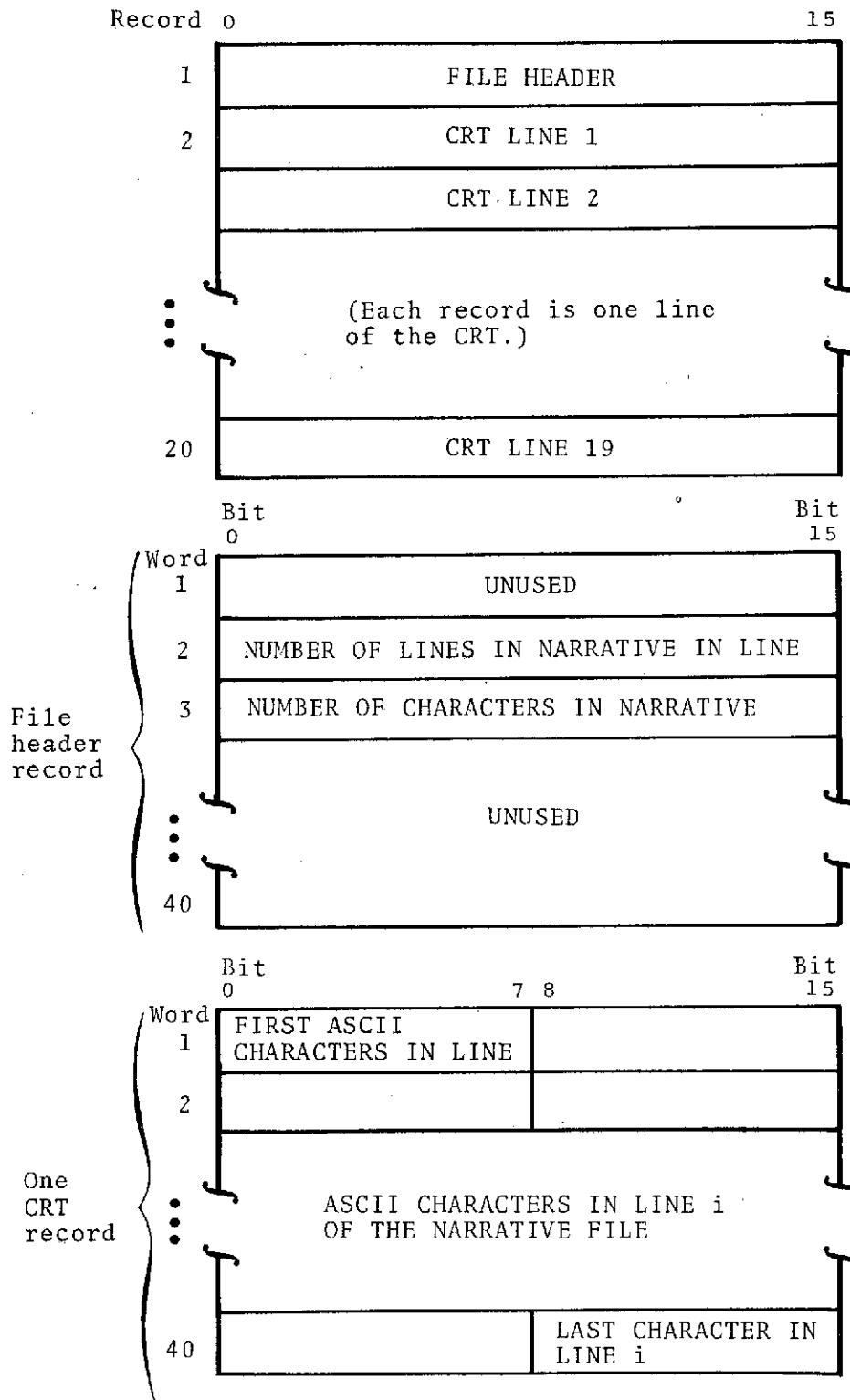


Figure 2-2. - Narrative File format.

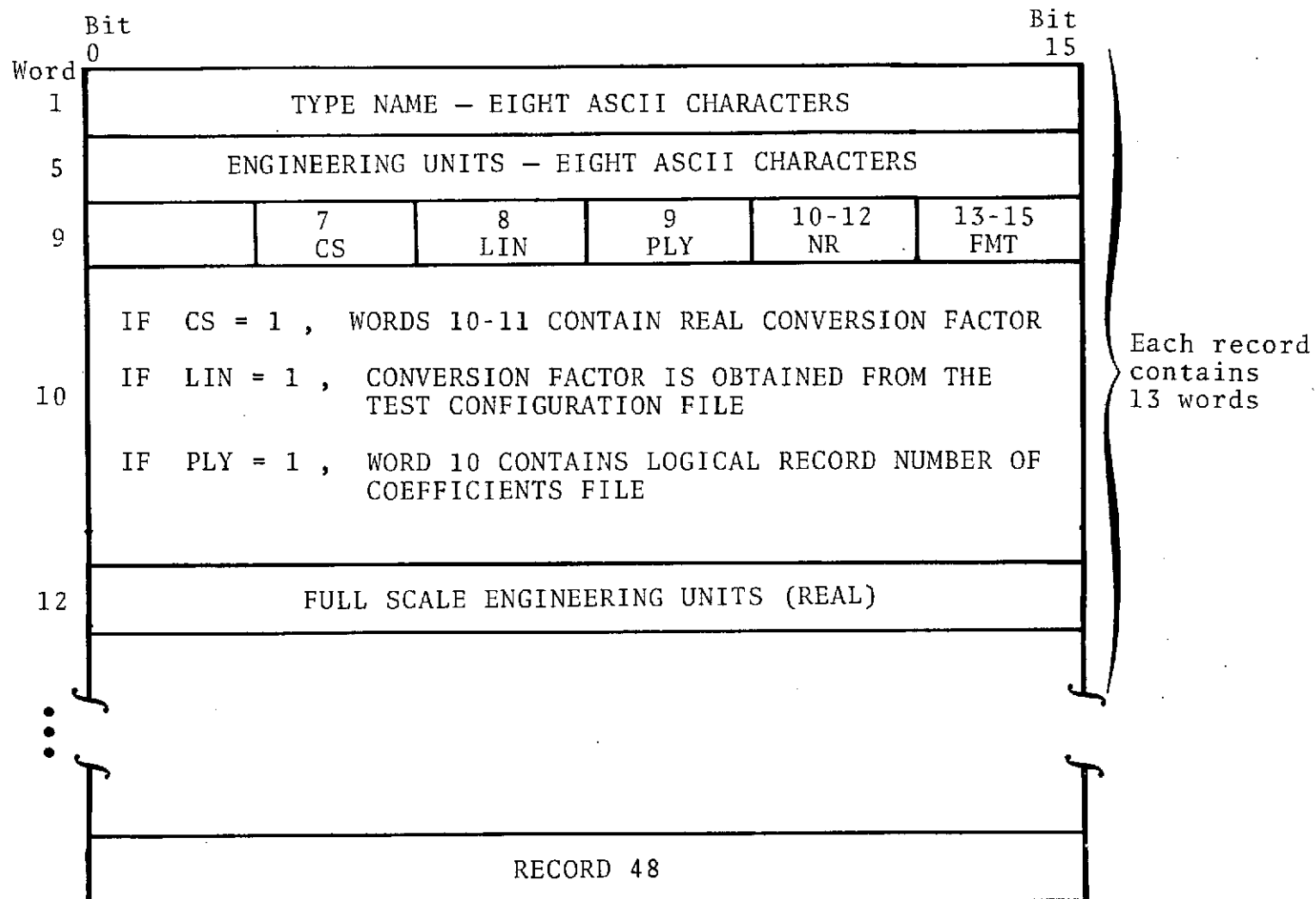


Figure 2-3. - Type File format.

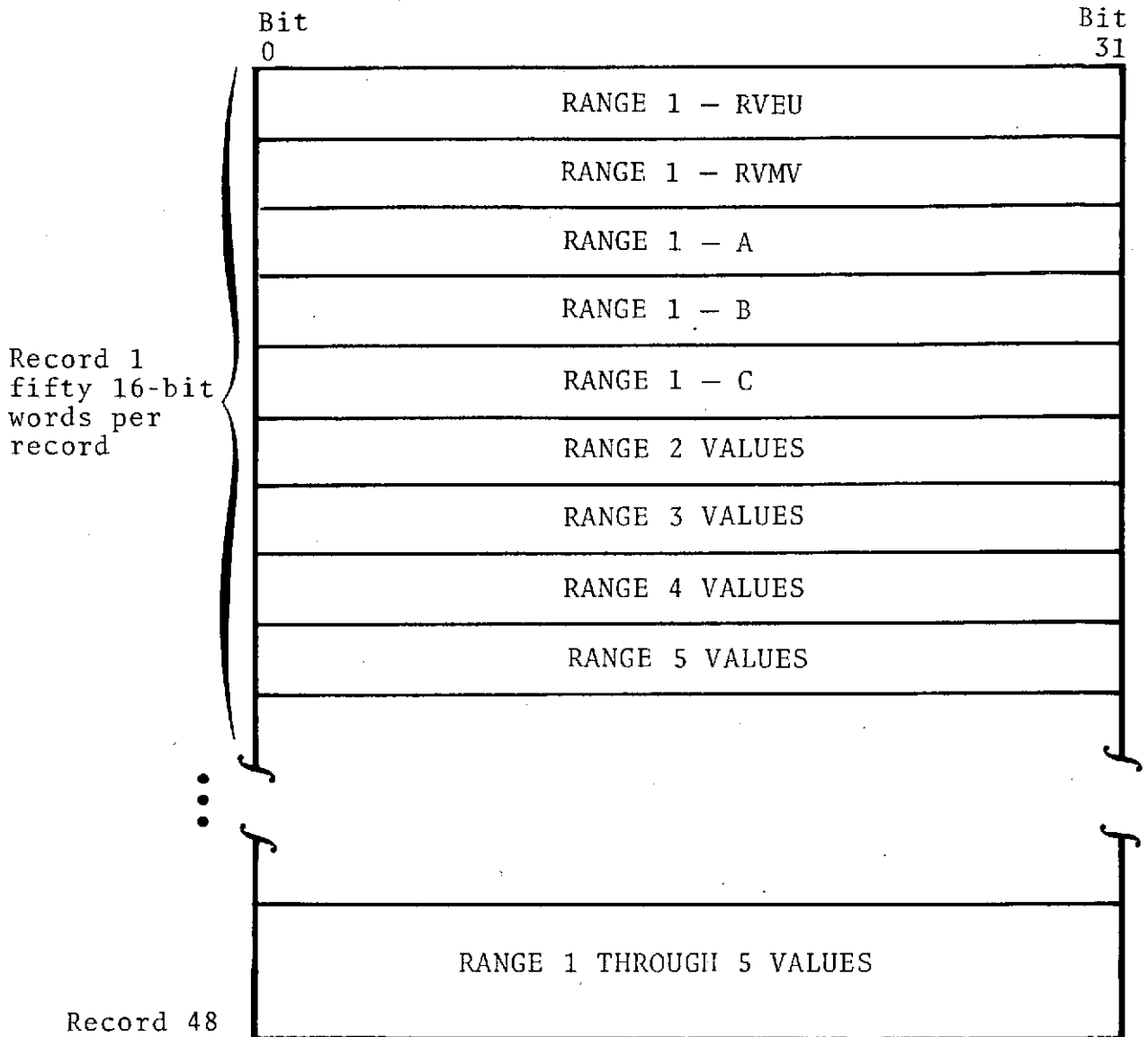
following codes for the conversion and display of data for the specific transducer type. PLY is the only variable in word 9 used for post-test processing.

<u>Code</u>	<u>Definition</u>
CS	Conversion factor supplied - If bit 7 is on, a manufacturer's conversion constant will be contained in words 10-11 of the Type File record.
LIN	Linear conversion required - If bit 8 is on, conversion will be required using the calibration constant (CALK) (words 10-11 in the Test Configuration File).
PLY	Polynomial conversion required - If bit 9 is on, polynomial conversion will be required. Word 10 in the record will contain the logical record number in the Coefficients File, in which the coefficients for the transducer type are located.
NR	Number of polynomial ranges - If PLY = 1 , NR will be a number from 1 to 5 which reflects the number of segments for the particular polynomial (maximum of 5 segments, order to be supplied).
FMT	Display format - This code will be used for real-time display:  = 0, I8 format will be used.  ≠ 0, F8.FMT format will be used.

2.1.1.3 Coefficients File. The Coefficients File contains polynomial coefficients for converting thermo-couple and other transducer millivolt output to engineering units (EU). It also contains coefficients for temperature correction of strain-gauge data. Each record contains the upper millivolt range limits and engineering units limits for each segment. Each range limit is associated with the second degree polynomial which follows in the record. The format is shown in figure 2-4. All information contained in this file is pertinent to the processing of the test data.

The RHTF program will have the capacity to provide up to 48 polynomials -- one for each type transducer identified in the Type File. The file contains 48 records with each record consisting of fifty 16-bit words.

2.1.1.4 Test Configuration File. The Test Configuration File contains information for data acquisition, links to type tables, minimum/maximum values for limit-checking, and an engineering units conversion factor or pointer to a coefficients table entry. There is a total of 276 records in the file with each record containing thirteen 16-bit words. One record exists for each channel; i.e., records 1 to 256 correspond to channels 0 to 255. Records 257 to 276 will contain CAN coded channel names. The format of the Test Configuration File is shown in figure 2-5. Flag definitions are given beginning on page 2-10. Variables annotated with an asterisk (\*) are necessary for post-test processing. A "1" indicates a bit is on.



RVEU = Limit in engineering units (floating point)

RVMV = Limit in millivolts (floating point)

A,B,C = Polynomial coefficients (floating point)  
for equation  $A(\text{mV})^2 + B(\text{mV}) + C$

Figure 2-4. - Coefficients File format.

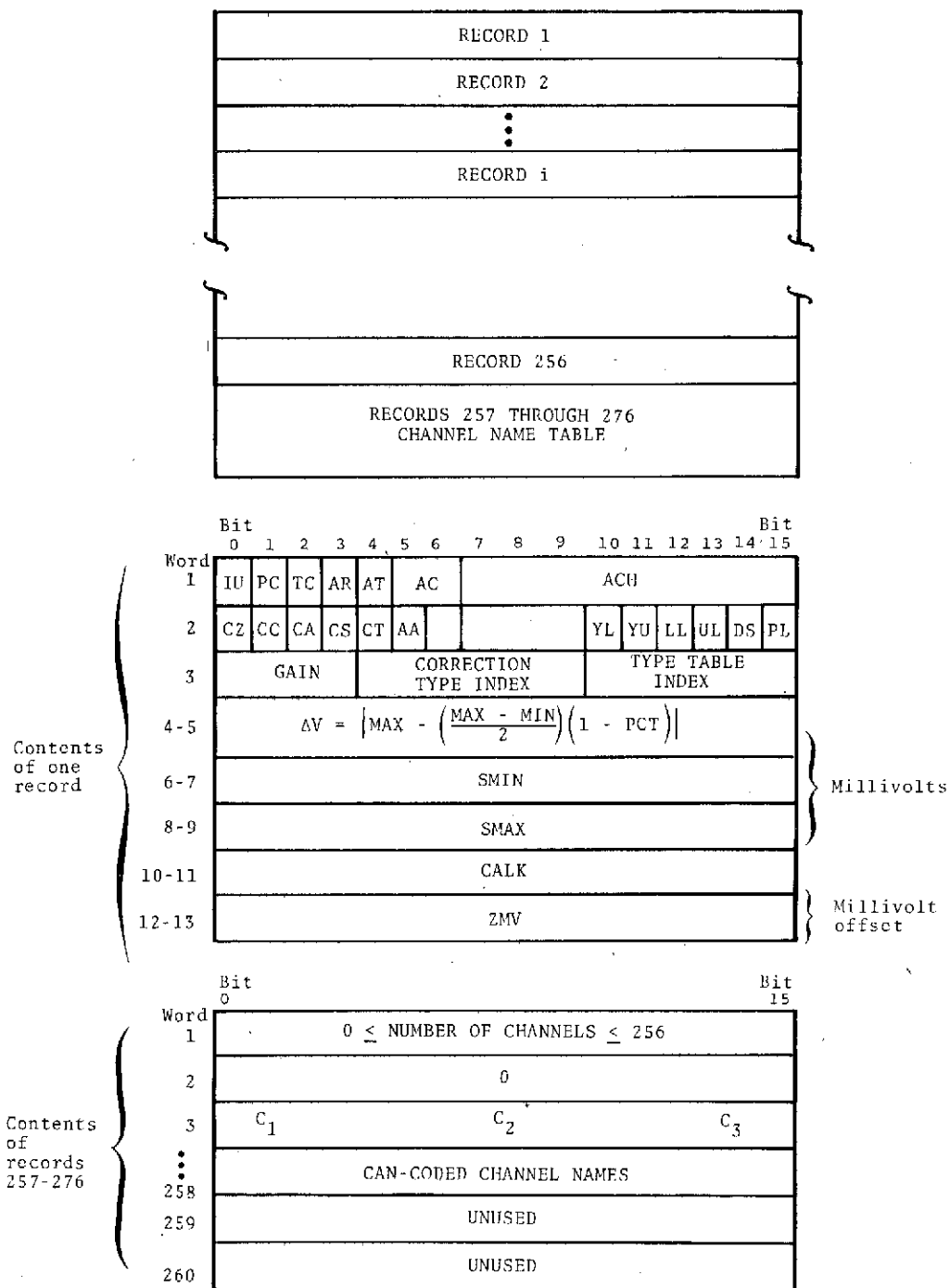


Figure 2-5. — Test Configuration File format.

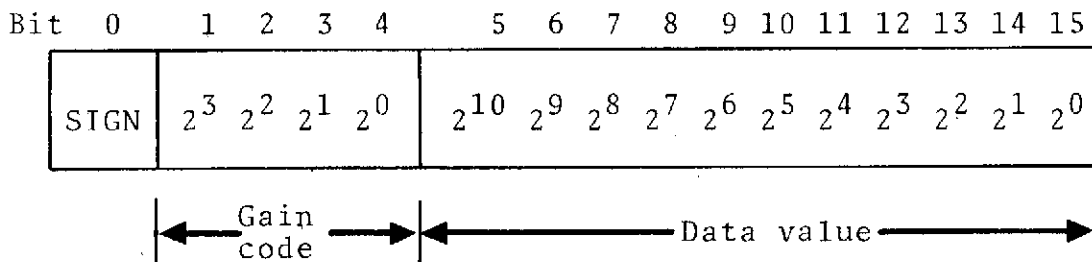
<u>Code</u>	<u>Definition</u>
IU*	A flag to indicate the channel is in use.
PC*	A flag to indicate polynomial conversion is required.
TC*	A flag to indicate temperature correction is required; e.g., strain data.
AR*	A flag to indicate that automatic ranging of the gain was utilized to provide maximum resolution of the analog-to-digital (A/D) converter.
AT	A flag to indicate alarm type for real-time control: 0 = soft, 1 = hard (meaningful only if AC $\neq$ 0).
AC	A two-bit alarm code to be used in real-time control.
ACH*	Associated channel number for temperature correction. If TC = 1, this field contains the channel number of the thermocouple data to use in the computation.
CZ	A flag to indicate the zero-milli-volt offset (ZMV) is computed for the channel.
CC	A flag to indicate the calibration constant (CALK) is computed.

<u>Code</u>	<u>Definition</u>
CA	A flag to indicate the calculated CALK meets acceptance criteria.
CS	A flag to indicate the CALK is supplied in the Test Configuration File.
CT	A flag to indicate the CALK in the Test Configuration File is supplied by the test director.
AA	A flag to indicate an alarm condition will be acknowledged during real-time processing.
YL	A flag to indicate an online minimum (MIN) limit check.
YU	A flag to indicate an online maximum (MAX) limit check.
LL	A flag to indicate a MIN exists.
UL	A flag to indicate a MAX exists.
DS	A flag to indicate that this channel is a member of a display group on the Groups File.
PL	A flag to indicate that this channel is a member of a plot group on the Groups File.
GAIN	A code to indicate the gain is applied to the transducer output for A/D conversion.
SMIN	Soft minimum.

<u>Code</u>	<u>Definition</u>
SMAX	Soft maximum.
PCT	Percent.
CORRECTION TYPE INDEX*	An index to the Type File to locate the correction to be applied to the data: TC = 1 and ACH = 0 to 225 .
TYPE TABLE INDEX*	An index to the Type File to locate the conversion type to be applied to the data.
$\Delta V$	A value used in checking for alarm conditions during the test.
SMIN	A value used in checking for alarm conditions during the test.
SMAX	A value used in checking for alarm conditions during the test.
CALK*	Calibration constant either calculated or supplied by the test director.
ZMV*	A value in millivolts which represents zero engineering units.
C <sub>1</sub> , C <sub>2</sub> , C <sub>3</sub> *	CAN-coded characters contained in the 16-bit data word to identify each channel. (See appendix for data word definition.)

2.1.1.5 Groups File. The Groups File contains records which identify data channel groups that are to be output during real-time and/or post-test processing. Each record (16 words) is a bit map, where each bit (0 through 255) corresponds to a channel (0 through 255). The format is shown in figure 2-6.

2.1.1.6 Test Data File. The Test Data File contains the time history samples of 256 channels at a system sample rate of 2,560 samples per second. Each record is 2,561 16-bit words in length with time being the first word in integer seconds and data in integer counts. The data word is as follows:



<u>Bit</u>	<u>Function</u>
0	Specifies the sign of the data value 0 = postiive value. 1 = negative value.
1-4	Specifies the gain (code).
5-15	Specifies the data value. Negative values are in Two's Complement format.

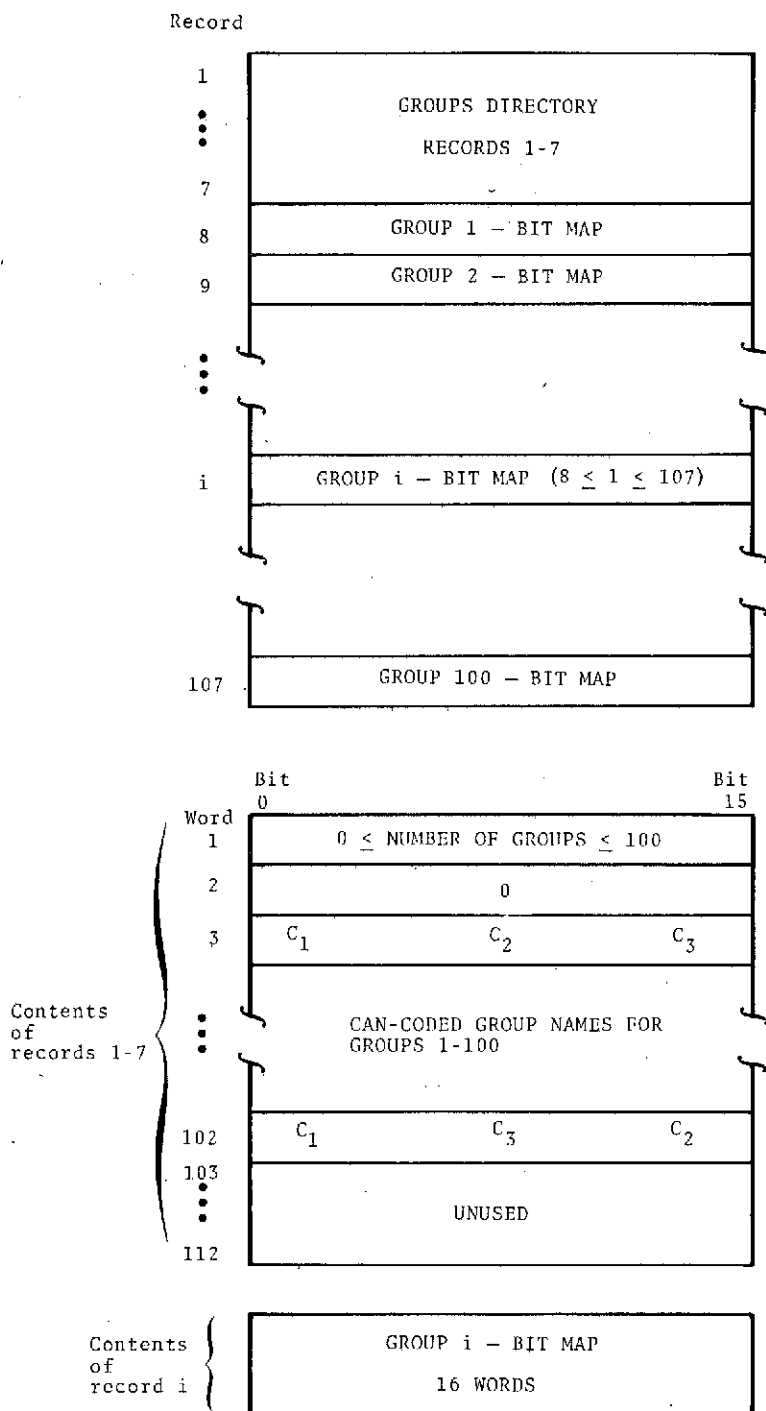


Figure 2-6. - Groups File format.

The following gain codes are applicable:

<u>Gain code</u>	<u>Gain</u>	<u>Range</u>
11	1	$\pm 10.24$ V
10	2	$\pm 5.12$ V
9	4	$\pm 2.56$ V
8	8	$\pm 1.28$ V
7	16	$\pm 640$ mV
6	32	$\pm 320$ mV
5	64	$\pm 160$ mV
4	128	$\pm 80$ mV
3	256	$\pm 40$ mV
2	512	$\pm 20$ mV
1	1024	$\pm 10$ mV
0	2084	$\pm 5$ mV

At a gain code of 11,  $\pm 10.24$  volts = 2047 counts or 200 counts per volt from the A/D converter.

Ten scans of data appear in a record for each time word. The maximum output recording rate is one record per second. A recording mode of every nth record is also available. The format is shown in figure 2-7.

#### 2.1.2 Lead Cards

The input lead cards will contain information for program control. Provision should be made for supplying variable information to override data obtained from the descriptive or pretest files. Additional content will be outlined in the design specification for the RIITF program.

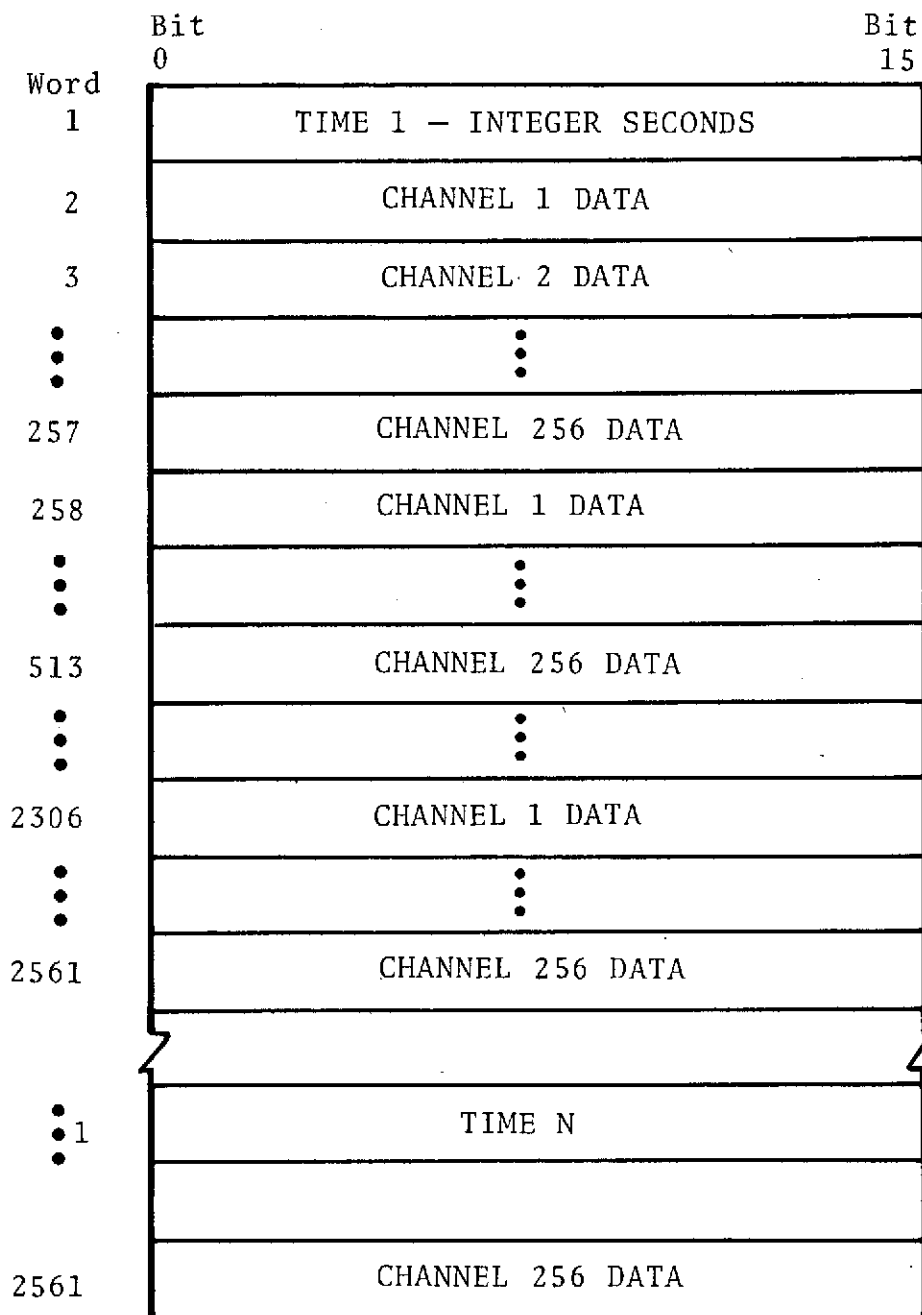


Figure 2-7. - Test Data File format.

## 2.2 PROCESSING REQUIREMENTS

The processing of radiant-heat-test data requires conversion of raw data contained on the Test Data File for thermocouples, strain gauges, linear transducers, and radiometers. Conversion coefficients are contained on the tape for segmented polynomials and exponential and linear constants. The method for applying the correct conversion is interrelated to the control information in the Test Configuration File, the Type File, and the Coefficients File. All coefficients, with the exception of thermocouple conversions, will normally be obtained from the tape.

An option to override coefficients on tape and/or supply coefficients via lead cards will be required. Accuracies provided by the coefficients for thermocouple curves contained on tape are inadequate for post-test processing. Current National Bureau of Standards (NBS) coefficients will be provided by the customer, or routines in existing programs will be used. The program will also be required to thermally correct strain data utilizing coefficients provided on tape or lead card.

Data being acquired by RHDACS may be recorded subject to an automatic gain ranging technique, which provides maximum resolution through the A/D conversion process. The gain code will be included in the data word. The process of converting to engineering units will account for the change in gains.

The procedure for converting the count values for each channel in the Test Data File to engineering units is as follows:

1. For each record in the Test Configuration File, if IU in word 1 is equal to one, the channel is in use and will be processed. If it is not equal to one, no processing will be required.
2. The data value obtained from the Test Data File, which sequentially corresponds to the Test Configuration File record, will be converted to millivolts by the equation

$$mV = \frac{5x}{G} - ZMV \quad (1)$$

where  $x$  is the count value,  $G$  is the gain, and  $ZMV$  is the zero millivolt offset. The gain code to gain relationship is shown in section 2.1.1.6. If in word 1 of the Test Configuration File, AR is equal to zero,  $ZMV$  will be obtained from the Test Configuration File. If AR is equal to one, automatic gain ranging has been employed and the  $ZMV$  offset for each gain used will be obtained from a location on the tape to be defined at a later date.

3. The 10 data values contained in an input record for each channel will be averaged, and the average value will be used for further processing. The time value will not be altered and obtained from the first word of the record.

4. To convert the millivolt values to engineering units, word 1 of the Test Configuration File record will be checked to determine if PC equals one. If so, polynomial conversion will be required using the equation

$$EU = A(mV)^2 + B(mV) + C \quad (2)$$

where A, B and C are the millivolt to engineering unit conversion coefficients obtained from the Coefficients File or lead card and mV is the millivolt value.

5. To obtain the coefficients for the polynomial, a two step retrieval process will be necessary. First, the logical record number for the instrument type in the Type File will be located in the Type Table Index in word 3 of the Test Configuration File. Next, the logical record number for the coefficients in the Coefficients File will be found in word 10 of the Type File record. The variable PLY in word 9 of the Type File record must also be equal to one.
6. If the variable PC is not equal to one, linear conversion will be required using the equation

$$EU = CALK (mV) \quad (3)$$

where CALK is the linear constant obtained from the Test Configuration File and mV is the data value in millivolts.

7. The engineering units label will be obtained from the Type File for each channel by use of the logical record number in the Type Table Index in word 3 of the Test Configuration File record.
8. An exponential conversion procedure using the equation

$$EU = \frac{K}{\ln (mV/A)} \quad (4)$$

is to be defined by the customer for incorporation into the program at a further date. K and A are constants to be obtained from a location on tape (to be specified) or from a lead card. The data value is mV.

9. If in word one of the Test Configuration File record, TC is equal to one, the channel is to be thermally corrected by the equation

$$S_c = S - [A(T)^2 + B(T) + C] \quad (5)$$

where  $S_c$  is corrected strain, S is the observed strain in engineering units, A, B and C are coefficients for the material type and T is the temperature (time correlated) associated with the strain data. The temperature channel to use will be contained in the variable ACH in word 1 of the same Test Configuration File record. The coefficients will be obtained from lead cards on the Coefficients File using the same procedure as

identified in 5 above. However, the Correction Type Index in word 3 of the record will be used instead of the Type Table Index.

## 2.3 OUTPUT REQUIREMENTS

Output from the program will consist of: time history tabular listings of parameters in engineering units (averaged), time history plots of selected parameters (averaged), and quality control and diagnostic information to facilitate data quality verification and troubleshooting.

### 2.3.1 Tabular Listings

The format of the tabular data should provide for a test ID, parameter ID's, and as many parameters per page as are deemed feasible. Data will be output on a tabular group basis as defined in the Groups File. However, control over which groups are output will be necessary. A group may be identified in the Groups File with more measurements than can be contained on a single page.

Each active channel or measurement, as indicated by the Test Configuration File, will have an indicator if it is a member of a display group. In this event, the channel will be flagged in the Groups File for each group to be displayed or output.

Because only three-character, CAN-coded, parameter ID's or channel names will be available from the Test Configuration File, provision must be made to accept expanded names

for each measurement to be output. The test title may also be input on cards instead of being obtained from the description in the Narrative File.

### 2.3.2 Time History Plots

Capability to generate time history plots, requiring a minimum number of lead cards, should include the following:

- A major heading to be specified at the top of each microfilm frame.
- One grid per microfilm frame.
- One to five measurements plotted per grid.  
(Each grid may have a different number of measurements plotted.)
- Identification of each measurement plotted on a given grid at the top of that grid, including the alphabetical symbol used to designate plotted data when more than one measurement has been plotted on that grid.
- One ordinate scale per grid, regardless of the number of measurements plotted.
- Lead card specification or program computation of ordinate scale for each grid. (If the ordinate scale is computed, major divisions should be a power of ten times 1, 2, or 5.)
- Specification of ordinate scale engineering units centered on the left side of each grid.
- Optional specification of allowable abscissa interval.

- Abscissa specified as elapsed time, designated in hours, minutes, or seconds, as is appropriate with the abscissa description centered and labeled as such below the grid and abscissa scale.
- Linear or continuous nonlinear abscissa scale. (A continuous nonlinear abscissa scale is a scale composed of less than eleven linear segments expanded or compressed to give the requested data resolution over the grid interval. Each segment should be specified by lead card.)
- Optional data thinning. When data thinning is specified, a data point should not be plotted unless it is at least one raster, in any direction, from the last point plotted. The number of rasters will be a lead card option. The necessity for this capability stems from the previous requirement to provide a continuous nonlinear abscissa scale. The thinning technique is required for data to be plotted on a compressed time scale segment or an overexposed condition on the film will result.

### 2.3.3 Quality Control Output

Line printer output from the program will contain diagnostics of abnormalities encountered and information regarding processing activity. Items to be included are:

- Program lead cards
- Record counts
- Start and stop times of the data file processed

- Variable information utilized from the five descriptive files
- Parity record count

#### 2.3.4 Binary Tape

A time history binary tape containing the averaged data values should be produced on option for use in further processing.

### 2.4 PERFORMANCE REQUIREMENTS

This program will conform to established standards and procedures for program development.

### 3.0 TEST REQUIREMENTS

#### 3.1 TEST DATA SOURCES

A test tape will be generated by the RHDACS for use in program checkout and validation.

#### 3.2 GENERAL TEST APPROACH

The complexity of the RHDACS output tape format makes it impractical to generate a comprehensive test tape for program checkout and validation. The system must produce a test tape to accomplish the above. Preliminary checking will be made from card input and simulated test data to the extent possible.

#### 3.3 ACCEPTANCE CRITERIA

Because no test data will be available for comparative purposes, extensive checking of the program will be required. Results of test runs will be coordinated with the customer for approval.

#### 4.0 PRODUCTION IMPLEMENTATION

Program operating procedures will be prepared to provide the necessary information to implement the program into production. Procedures will also be prepared for inclusion in the Data Management Plan for the Data Reduction Complex.

## APPENDIX

### ASCII AND CAN CODE CHARACTER SETS

A compressed alphanumeric (CAN) character string is any combination of three CAN characters. The data word is generated by the following algorithm:

Given the character string END, generation will be as follows:

- Each character is assigned a CAN value as described in the following tables.

$$\left. \begin{array}{l} \text{END} = \text{C1 C2 C3} \\ \text{C1} = \text{E} = 5 \\ \text{C2} = \text{N} = 14 \\ \text{C3} = \text{D} = 4 \end{array} \right\} \text{(base 10)}$$

- Data word =  $(\text{C1} * 40 + \text{C2}) * 40 + \text{C3}$  (base 10)

$$\text{END} = 2174 \text{ (base 16)} = 8564 \text{ (base 10)}$$

This algorithm allows three characters to be packed in a 16-bit word. Valid CAN characters include the set A-Z, 0-9, colon (:), dollar (\$), period (.), and space.

ASCII character	Code	Line printer character	Code	Card reader	ANSI* card code	Teletype character	Code	EBCDIC <sup>†</sup> character	Code	Computer character	CAN code
EM	19			M.P.**	11-9-8-1	S1	99	EM	19		
SUB	1A			M.P.	9-8-7	S2	9A	SUB	3F		
ESC	1B			M.P.	0-9-7	S3	9B	ESC	27		
FS	1C			M.P.	11-9-8-4	S4	9C	FS	1C		
GS	1D			M.P.	11-9-8-5	S5	9D	GS	1D		
RS	1E			M.P.	11-9-8-6	S6	9E	RS	1E		
US	1F			M.P.	11-9-8-7	S7	9F	US	1F		
Space	20	Space	20	Space bar	-	Space	A0	Space	40	Space	0
!	21	!	21	!	12-8-7	!	A1	!	4F		
"	22	"	22	"	8-7	"	A2	"	7F		
#	23	#	23	#	8-3	#	A3	#	7B		
\$	24	\$	24	\$	11-8-3	\$	A4	\$	5B	\$	39
%	25	%	25	%	0-8-4	%	A5	%	6C		
&	26	&	26	&	12	&	A6	&	50		
'	27	'	27	'	8-5	'	A7	'	7D		
(	28	(	28	(	12-8-5	(	A8	(	4D		
)	29	)	29	)	11-8-5	)	A9	)	5D		
*	2A	*	2A	*	11-8-4	*	AA	*	5C		
+	2B	+	2B	+	12-8-6	+	AB	+	4E		
^	2C	^	2C	^	0-8-3	^	AC	^	6B		
-	2D	-	2D	-	11	-	AD	-	60		
•	2E	•	2E	•	12-8-3	•	AE	•	4B		38
/	2F	/	2F	/	0-1	/	AF	/	61		
0	30	0	30	0	0	0	B0	0	F0	0	27
1	31	1	31	1	1	1	B1	1	F1	1	28
2	32	2	32	2	2	2	B2	2	F2	2	29

\*ANSI = American National Standards Institute

<sup>†</sup>EBCDIC = Extended Binary Coded Decimal Interchange Code

\*\*M.P. = Multipunch

ASCII character	Code	Line printer character	Code	Card reader	ANSI card code	Teletype character	Code	EBCDIC character	Code	Computer character	CAN code
3	33	3	33	3	3	3	B3	3	F3	3	30
4	34	4	34	4	4	4	B4	4	F4	4	31
5	35	5	35	5	5	5	B5	5	F5	5	32
6	36	6	36	6	6	6	B6	6	F6	6	33
7	37	7	37	7	7	7	B7	7	F7	7	34
8	38	8	38	8	8	8	B8	8	F8	8	35
9	39	9	39	9	9	9	B9	9	F9	9	36
:	3A	:	3A	:	8-2	:	BA	:	7A	:	37
;	3B	;	3B	;	11-8-6	;	BB	;	5E		
<	3C	<	3C	<	12-8-4	<	BC	<	4C		
=	3D	=	3D	=	8-6	=	BD	=	7E		
>	3E	>	3E	>	0-8-6	>	BE	>	6E		
?	3F	?	3F	?	0-8-7	?	BF	?	6F		
@	40	@	40	@	8-4	@	C0	@	7C		
A	41	A	41	A	12-1	A	C1	A	C1	A	1
B	42	B	42	B	12-2	B	C2	B	C2	B	2
C	43	C	43	C	12-3	C	C3	C	C3	C	3
D	44	D	44	D	12-4	D	C4	D	C4	D	4
E	45	E	45	E	12-5	E	C5	E	C5	E	5
F	46	F	46	F	12-6	F	C6	F	C6	F	6
G	47	G	47	G	12-7	G	C7	G	C7	G	7
H	48	H	48	H	12-8	H	C8	H	C8	H	8
I	49	I	49	I	12-9	I	C9	I	C9	I	9
J	4A	J	4A	J	11-1	J	CA	J	D1	J	10
K	4B	K	4B	K	11-2	K	CB	K	D2	K	11
L	4C	L	4C	L	11-3	L	CC	L	D3	L	12
M	4D	M	4D	M	11-4	M	CD	M	D4	M	13
N	4E	N	4E	N	11-5	N	CE	N	D5	N	14
O	4F	O	4F	O	11-6	O	CF	O	D6	O	15

ASCII character	Code	Line printer character	Code	Card reader	ANSI card code	Teletype character	Code	EBCDIC character	Code	Computer character	CAN code
P	50	P	50	P	11-7	P	D0	P	D7	P	16
Q	51	Q	51	Q	11-8	Q	D1	Q	D8	Q	17
R	52	R	52	R	11-9	R	D2	R	D9	R	18
S	53	S	53	S	0-2	S	D3	S	E2	S	19
T	54	T	54	T	0-3	T	D4	T	E3	T	20
U	55	U	55	U	0-4	U	D5	U	E4	U	21
V	56	V	56	V	0-5	V	D6	V	E5	V	22
W	57	W	57	W	0-6	W	D7	W	E6	W	23
X	58	X	58	X	0-7	X	D8	X	E7	X	24
Y	59	Y	59	Y	0-8	Y	D9	Y	E8	Y	25
Z	5A	Z	5A	Z	0-9	Z	DA	Z	E9	Z	26
[	5B	[	5B	†	12-8-2	[	DB	†	4A		
\	5C	\	5C	0-8-2	0-8-2	\	DC	\	E0		
]	5D	]	5D	!	11-8-2	]	DD	!	5A		
^	5E	^	5E	—	11-8-7	↑	DE	^	5F		
—	5F	—	5F	—	0-8-5	←	DF	—	6D		
,	60			M.P.	8-1			,	79		
a	61			M.P.	12-0-1			a	81		
b	62			M.P.	12-0-2			b	82		
c	63			M.P.	12-0-3			c	83		
d	64			M.P.	12-0-4			d	84		
e	65			M.P.	12-0-5			e	85		
f	66			M.P.	12-0-6			f	86		
g	67			M.P.	12-0-7			g	87		
h	68			M.P.	12-0-8			h	88		
i	69			M.P.	12-0-9			i	89		
j	6A			M.P.	12-11-1			j	91		
k	6B			M.P.	12-11-2			k	92		
l	6C			M.P.	12-11-3			l	93		

ASCII character	Code	Line printer character	Code	Card reader	ANSI card code	Teletype character	Code	EBCDIC character	Code	Computer character	CAN code
m	6D			M.P.	12-11-4			m	94		
n	6E			M.P.	12-11-5			n	95		
o	6F			M.P.	12-11-6			o	96		
p	70			M.P.	12-11-7			p	97		
q	71			M.P.	12-11-8			q	98		
r	72			M.P.	12-11-9			r	99		